Abstract
The study of biological vision and the creation of artificial vision systems are naturally intertwined – exploration of the neuronal substrates of visual processing provides clues and inspiration for artificial systems, and artificial systems, in turn, serve as important generators of new ideas and working hypotheses. However, while systems neuroscience has provided inspiration for some of the “broad-stroke” properties of the visual system, much is still unknown. Even for those qualitative properties that most biologically-inspired models share, experimental data currently provide little constraint on their key parameters. Consequently, it is difficult to truly evaluate a set of computational ideas, since the performance of a model depends strongly on its particular instantiation – the size of the pooling kernels, the number of units per layer, exponents in normalization operations, etc.

To pave a way forward, we have developed a high-throughput approach to more expansively explore the possible range of biologically-inspired models, including models of larger, more realistic scale, leveraging recent advances in commodity stream processing hardware - particularly high-end NVIDIA GPUs. In analogy to high-throughput screening approaches in molecular biology and genetics, we generated and trained thousands of potential network architectures and parameter instantiations, and “screened” the visual representations produced by these models using an object recognition task. From these candidate models, the most promising were selected for further analysis.

We show that this approach can yield significant, reproducible gains in performance across an array of basic object recognition tasks, consistently outperforming a variety of state-of-the-art purpose-built vision systems from the literature. We further show that this approach can be used to find feature representations that achieve excellent performance across a variety of test sets, including the modern “Labeled Faces in the Wild” unconstrained face recognition benchmark and a new large-scale face set derived from the popular Facebook social networking website.

We also highlight how the application of flexible programming tools, such as high-level scripting, template metaprogramming and auto-tuning, can enable large performance gains, while managing complexity for the developer.

Metaprogramming
Recipe:
1) Use scripting (e.g., Python), templates and PyCUDA,
2) Instrumentalize your code,
3) Let the computer auto-tune it!

GPU performance
• bio-inspired architecture
• 52 free parameters
• >10^3 models

Best models on LFW and Facebook100!
High-throughput Screening
State-of-the-art Performance

Proof of concept: High-throughput screening
We discovered models that outperform the state-of-the-art in computer vision... (object and face recognition)

Take home message:
GPU Metaprogramming and Auto-tuning dramatically accelerates the discovery of bio-inspired vision models that beat state-of-the-art computer vision systems